CLAIMS

1. An atomic layer deposition method, comprising:

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the atomic layer deposition chamber effective to form a first monolayer on the substrate, said first precursor gas flowing comprising a plurality of first precursor gas pulses, the plurality of first precursor gas pulses comprising at least one total period of time between two immediately adjacent first precursor gas pulses when no gas is fed to the chamber; and

after forming the first monolayer on the substrate, flowing a second precursor gas different in composition from the first to the substrate within the deposition chamber effective to form a second monolayer on the first monolayer.

2. The method of claim 1 wherein the plurality is two.

3. The method of claim 1 wherein the plurality is more than two.

4. The method of claim 1 comprising flowing at least one inert purge gas pulse to the substrate within the chamber intermediate the first precursor flowing and the second precursor flowing.

5. The method of claim 1 comprising flowing multiple time spaced inert purge gas pulses to the substrate within the deposition chamber intermediate the first precursor flowing and the second precursor flowing.

6. The method of claim 1 comprising flowing at least one inert purge gas pulse to the substrate within the chamber immediately prior to the first precursor flowing.

7. The method of claim 1 wherein the first precursor comprises $TiCl_4$ and the second precursor comprises NH_3.

8. The method of claim 1 wherein the first precursor comprises NH_3 and the second precursor comprises $TiCl_4$.

9. The method of claim 1 wherein the first precursor comprises trimethylaluminum and the second precursor comprises ozone.

10. The method of claim 1 wherein the first precursor comprises ozone and the second precursor comprises trimethylaluminum.

11. The method of claim 1 wherein the total period of time is less than time of gas flow of either of the two immediately adjacent first precursor gas pulses.

12. The method of claim 1 wherein the total period of time is greater than time of gas flow of each of the two immediately adjacent first precursor gas pulses.

13. The method of claim 1 wherein the total period of time is greater than time of gas flow of both of the two immediately adjacent first precursor gas pulses in combination.

14. The method of claim 1 wherein the two immediately adjacent pulses are equal in time.

15. The method of claim 1 wherein the two immediately adjacent pulses are not equal in time.

16. The method of claim 1 wherein the two immediately adjacent pulses are equal in time, the total period of time being equal to the time of each of the immediately adjacent pulses.

17. An atomic layer deposition method, comprising:

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the atomic layer deposition chamber effective to form a first monolayer on the substrate;

after forming the first monolayer on the substrate, flowing a second precursor gas different in composition from the first to the substrate within the deposition chamber effective to form a second monolayer on the first monolayer;

after forming the second monolayer on the substrate, flowing a third precursor gas different in composition from the second to the substrate within the deposition chamber effective to form a third monolayer on the substrate; and

said second precursor gas flowing comprising a plurality of time spaced second precursor gas pulses intermediate the first and third precursor gas flowings.

18. The method of claim 17 wherein the third precursor is the same in composition as the first precursor.

19. The method of claim 17 wherein the third precursor is different in composition from the first precursor.

20. The method of claim 17 comprising at least one total period of time between two adjacent second precursor gas pulses when no gas is fed to the chamber.

21. The method of claim 17 comprising at least one total period of time between two adjacent second precursor gas pulses when some gas is fed to the chamber.

22. The method of claim 17 comprising at least one total period of time between two adjacent second precursor gas pulses within which at least one inert purge gas pulse is fed to the substrate within the chamber.

23. The method of claim 17 wherein the plurality is two.

24. The method of claim 17 wherein the plurality is more than two.

25. The method of claim 17 wherein the plurality is two, and comprising a total period of time between said two when no gas is fed to the chamber.

26. The method of claim 17 wherein the plurality is two, and comprising a total period of time between said two when some gas is fed to the chamber.

27. The method of claim 17 wherein the plurality is two, and comprising a total period of time between said two within which at least one inert purge gas pulse is fed to the substrate within the chamber.

28. The method of claim 17 comprising flowing at least one inert purge gas pulse to the substrate within the chamber intermediate the first precursor flowing and the third precursor flowing.

29. The method of claim 17 comprising flowing multiple time spaced inert purge gas pulses to the substrate within the deposition chamber intermediate the first precursor flowing and the third precursor flowing.

30. An atomic layer deposition method, comprising:

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the atomic layer deposition chamber effective to form a first monolayer on the substrate;

after forming the first monolayer on the substrate, flowing a second precursor gas different in composition from the first to the substrate within the deposition chamber effective to form a second monolayer on the first monolayer;

after forming the second monolayer on the substrate, flowing a third precursor gas different in composition from the second to the substrate within the deposition chamber effective to form a third monolayer on the substrate; and

said second precursor gas flowing comprising at least two time abutting second precursor gas pulses intermediate the first and third precursor gas flowings, said two time abutting second precursor gas pulses being characterized by different flow rates of the second precursor.

31. The method of claim 30 wherein said two time abutting second precursor gas pulses are equal in time.

32. The method of claim 30 wherein a first in time of said two time abutting second precursor gas pulses is greater in flow time than that of a second in time of an immediately adjacent of said two time abutting second precursor gas pulses.

33. The method of claim 30 wherein a second in time of said two time abutting second precursor gas pulses is greater in flow time than that of a first in time of an immediately adjacent of said two time abutting second precursor gas pulses.

34. The method of claim 30 comprising flowing at least one inert purge gas pulse to the substrate within the chamber intermediate the first precursor flowing and the third precursor flowing.

35. The method of claim 30 comprising flowing multiple time spaced inert purge gas pulses to the substrate within the deposition chamber intermediate the first precursor flowing and the third precursor flowing.

36. The method of claim 30 wherein the third precursor is the same in composition as the first precursor.

37. The method of claim 30 wherein the third precursor is different in composition from the first precursor.